LD 1440

Mist Blower Spraying of Longleaf Pine for Cone and Seed Insect Control

Gary L. DeBarr · Edward P. Merkel

USDA Forest Service Research Paper SE-76 · January 1971

MIST BLOWER SPRAYING OF LONGLEAF PINE FOR CONE AND SEED INSECT CONTROL

by

Gary L. DeBarr, Associate Entomologist
Forestry Sciences Laboratory, Athens, Georgia

and

Edward P. Merkel, Principal Entomologist
Naval Stores and Timber Production Laboratory, Olustee, Florida

In the past, longleaf pine, *Pinus palustris* Mill., has received little emphasis in the establishment of pine seed orchards in the southern United States. Recently, however, tree improvement programs have revived interest in this commercially important species. Consequently, we can expect seed orchard acreages of longleaf pine to expand noticeably in the future. This trend will undoubtedly be attended by an increased urgency to protect longleaf pine seed from destructive insects.

Wakeley (1931) reported damage by a coneworm, *Dioryctria amatella* Hulst, on longleaf pine. Wahlenberg (1946) also observed *D. amatella* cone damage in several southern states; in addition, he found cone damage caused by *D. abietella* (D. & S.). In Mississippi, conelet losses as high as 90 percent were primarily the result of *D. amatella* mining in twig terminals (Coyne and Allen 1956), whereas Shoulders (1968) found female strobili losses of 70 percent due to "insects and other agents" in a longleaf stand in Louisiana. Ebel (1963) summarized the insects known to affect longleaf pine seed production, and later studied the role of a beetle, *Ernobius granulatus* LeConte, in relation to longleaf conelet abortion, concluding that the beetle was a secondary invader of dead and dying conelets (Ebel 1964). Coyne (1968) reported that a seedworm, *Laspeyresia ingens* Heinrich, destroyed an average of 21 percent of the annual longleaf seed crop produced in the gulf coast region of the United States.

In early tests conducted at the Southern Institute of Forest Genetics, four bimonthly hydraulic sprayer applications of benzene hexachloride (BHC), beginning in March or April, increased first-year cone survival of longleaf pine (Allen and Coyne 1956; Coyne 1957). Merkel and Yandle (1965) reported that cone and seed losses caused by *Dioryctria* spp. were reduced by spraying slash pines with three mist blower applications of a 2.5 percent BHC or 1.0 percent azinphosmethyl (Guthion®) water emulsion. A single azinphosmethyl application controlled the slash pine seedworm, *L. anaranjada* Miller, whereas hydraulic sprayer or mist blower sprays of BHC were unsuccess-

ful. Later, Merkel (1968) found that a wetting spray of fenthion reduced *L. anaranjada* infestation in slash pine cones.

Numerous experiments (Buffam and Johnson 1966; Hedlin 1964, 1966; Johnson 1963; Johnson and Hedlin 1967; Johnson and Meso 1966; Johnson and Rediske 1964, 1965) in Washington State and British Columbia have shown that dimethoate, when used to thoroughly wet the foliage, is an effective systemic insecticide for the control of most insects infesting the cones of Douglas-fir, *Pseudotsuga menziesii* (Mirb.) Franco. Prior successes with dimethoate for the control of Douglas-fir cone and seed insects prompted us to conduct experiments in north Florida during 1966 and 1967 to evaluate this, along with several other promising insecticides for control of *Dioryctria* spp. and *Laspeyresia ingens* infesting longleaf pine cones.

MATERIALS AND METHODS

The experiments described in this paper were conducted during 1966-1968 on large, open-grown longleaf pines along a highway right-of-way in Columbia County, in northeast Florida. The trees were originally part of a natural stand of 48-year-old longleaf. They averaged 55 feet tall and 14 inches d.b.h. All the applications were made with a tractor-drawn John Bean Model 100F "Rotomist" mist blower nozzled to deliver 1.25 gallons per minute while operating at 300 p.s.i. pressure (fig. 1). In seed orchards, mist blowers are usually operated at a continuous slow speed (DeBarr and Merkel 1969); but since the trees we sprayed were not evenly spaced in rows, we stopped the mist blower on opposite sides of each tree in order to deliver the desired volume of material. The insecticides were applied shortly after sunrise, or before sunset, when wind conditions were the most ideal for thorough spray droplet distribution.

Figure 1.—Mist blower sprays longleaf pine for coneworm and seedworm control.

Water emulsions of the following materials were used in the spray tests on longleaf pine: (1) BHC liquid emulsifiable concentrate containing 1.0 pound of benzene hexachloride[1] gamma isomer per gallon of concentrate; (2) Guthion® emulsifiable concentrate containing 2 pounds actual azinphosmethyl[2] per gallon of concentrate; (3) Cygon® 267 containing 2.67 pounds of actual dimethoate[3] per gallon of concentrate; and (4) Bayer 29493 emulsifiable concentrate containing 4 pounds of actual fenthion[4] per gallon of concentrate (table 1).

Control of *Dioryctria* coneworms was evaluated at cone harvest by determining the proportion of the total number of second-year cones per tree which had been successfully attacked by larvae. In addition, for some tests coneworm attacks on both first- and second-year cones were recorded on 20 sample branches per tree in midsummer.

Effect of treatments against *Laspeyresia ingens* on longleaf pine was evaluated on the basis of the proportion of second-year cones infested in a 50-cone sample per tree. During the winter the samples were bisected with a table model cone cutter (DeBarr and Proveaux 1969) to expose overwintering larvae in the cone axis.

[1] (1,2,3,4,5,6 -hexachlorocyclohexane, mixed isomers).

[2] *O,O*-dimethyl *S*-4-oxo-1,2,3-benzotriazin-3 (4*H*)-ylmethyl phosphorodithioate.

[3] *O,O*-dimethyl *S*-(*N*-methylcarbamolymethyl) phosphorodithioate.

[4] *O,O*-dimethyl *O*-[4-(methylthio)-*m*-tolyl] phosphorothioate.

Table 1.—1966-1968 mist blower treatments for cone and seed insect control on longleaf pine, Columbia County, Florida

Test No.	Insecticide and concentration[1]	Application		Volume spray per tree	Active ingredient per:	
					Tree	Acre[2]
		No.	*Date*	*Gallons*	*- - Pounds - -*	
1	dimethoate (2.5%)	3	4/6[3]; 4/22;5/20/1966	1.3	0.28	13.3
	dimethoate (1.25%)	1	6/28/1966	1.3	.14	6.65
2	dimethoate (1.25%)	3	4/18; 6/13;7/6/1967	2.0	.21	10.0
3	fenthion (2.0%)	3	4/17; 6/14; 7/20/1967	2.0	.34	16.3
4	BHC (2.5%)	3	4/13; 5/16; 6/13/1968	2.0	.43	27.4
5	azinphosmethyl (1.0%)	3	4/12; 5/15; 6/14/1968	2.0	.17	7.76

[1]Percent concentration by weight of active toxicant.
[2]Based upon 48 trees/acre (30- by 30-foot spacing).
[3]Plyac® spreader-sticker added—2 pints/100 gallons.

RESULTS

***Dioryctria* control on first-year cones.**—*Dioryctria*-caused conelet mortality and the incidence of conelet abortion due to unknown causes were recorded only in tests 1, 2, and 3 (table 2). Three applications of 1.25 percent dimethoate reduced (94 percent) *Dioryctria* attacks significantly on first-year cones. In test 1, dimethoate was applied four times and at twice the amount of toxicant per tree as in test 2, but it failed to protect conelets from coneworm attack. Three applications of 2.0 percent fenthion did not reduce coneworm-caused conelet losses.

Aborted conelets on unsprayed trees averaged 20 percent in 1966 and 35 percent in 1967, and no significant reduction in abortion was detected on dimethoate- and fenthion-sprayed trees in either year (table 2).

***Dioryctria* control on second-year cones.**—The prevention of successful coneworm attacks on maturing cones is summarized in table 3. The incidence of coneworm infestation at midsummer was recorded only in the tests with dimethoate and fenthion. These insecticides reduced attacks through June, but control was not adequate, since little or no cone protection was afforded by the dimethoate and fenthion treatments from early July until cone harvest. However, BHC and azinphosmethyl significantly reduced cone infestation by 56- and 94-percent, respectively, for the entire summer (table 3).

Control of *Laspeyresia ingens* on second-year cones.—The results of all tests on the control of *L. ingens* are summarized in table 4. Of the four insecticides evaluated, only azinphosmethyl significantly reduced the numbers of infested cones. When compared with unsprayed checks, azinphosmethyl-sprayed trees had 88 percent fewer seedworm-infested cones. In addition, check trees had an average of 0.6 larva per cone, whereas cones from trees sprayed with azinphosmethyl averaged only 0.07 larva per cone (fig. 2).

Table 2.—First-year longleaf pine conelet abortion and infestation by *Dioryctria* spp. Mist blower treatments, Columbia County, Florida

Test No.	Insecticide	Observation date	Total conelets examined[1]	Conelet abortion[2]		Mean *Dioryctria* infestation per tree[3]		Reduction
				Checks	Sprays	Checks	Sprays	
			Number	*Percent*		*Percent*		*Percent*
1	dimethoate	6/15/1966	686	--	--	6.7	8.2	0
		11/1/1966	686	20.4	26.2	10.6	12.0	0
2	dimethoate	7/1/1967	883	34.9	33.8	2.7	.16	94*
3	fenthion	7/1/1967	893	34.9	44.5	2.7	5.5	0

[1]Based upon observations on conelets on a 20-branch/tree sample.
[2]Conelets dead from unknown cause(s).
[3]Eight or more trees (replicates) per treatment.
* = t-test of the difference between check and spray means significant (P = 0.05).

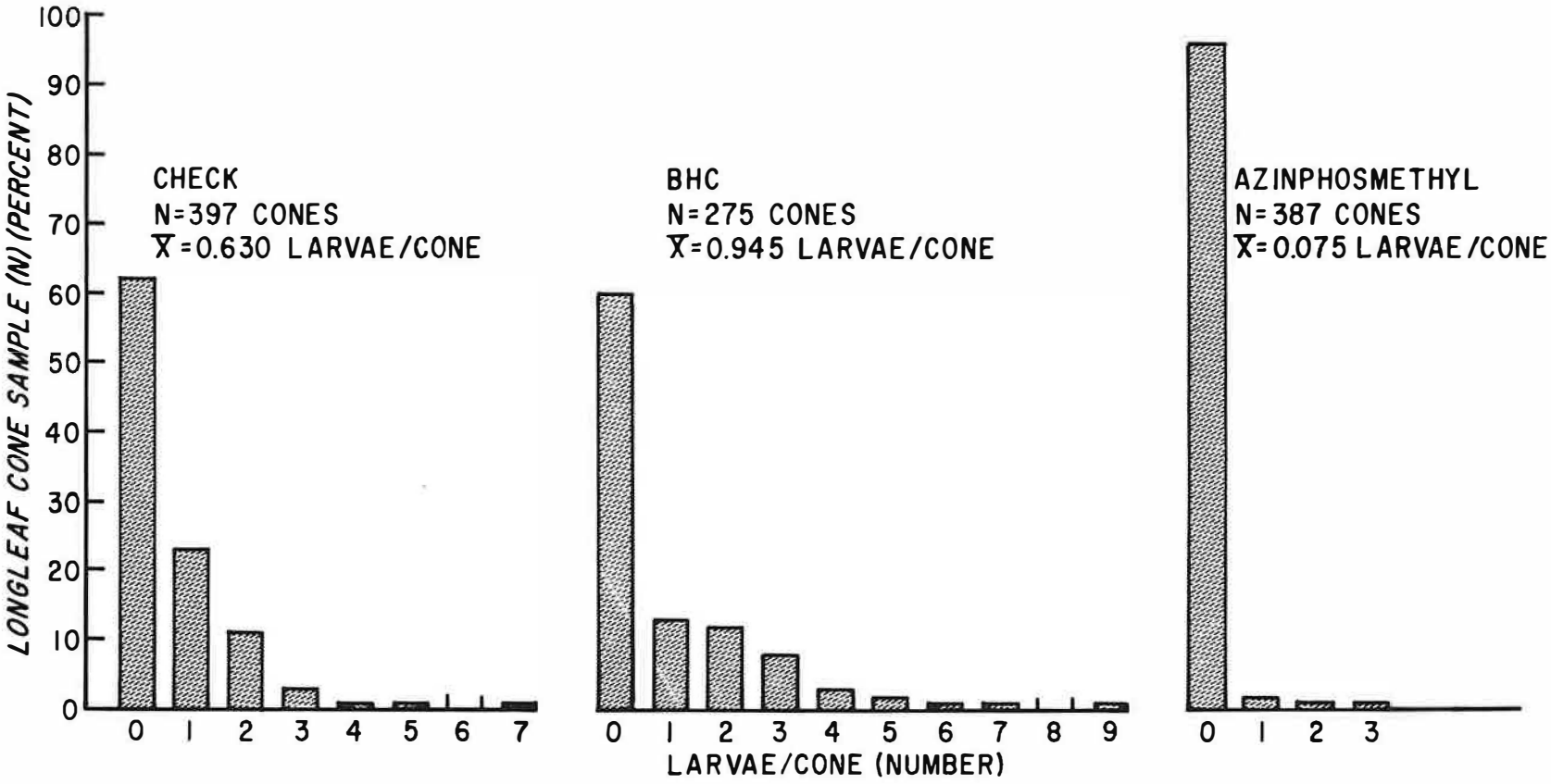

Figure 2.—Comparison of treatment effects on the incidence of larval infestation by *Laspeyresia ingens* in tests 4 and 5.

Table 3.—Second-year longleaf pine cone infestation by *Dioryctria* spp. Mist blower treatments, Columbia County, Florida

Test No.	Insecticide	Observation date	Total cones examined	Mean infestation per tree[1]		Reduction in cones infested
				Checks	Sprays	
			Number	*Percent*		*Percent*
1	dimethoate	6/15/66	[2]291	2.6	1.4	46 NS
		11/1/66	[2]291	46.0	29.7	35 NS
2	dimethoate	7/1/67	[2]534	14.2	8.3	41.5 NS
		11/1/67	[3]2,741	12.7	14.5	0 NS
3	fenthion	7/1/67	[2]712	14.2	8.1	43 NS
		11/1/67	[3]3,300	12.7	12.9	0 NS
4	benzene hexachloride	11/1/68	[3]1,544	16.6	7.3	56**
5	azinphosmethyl	11/1/68	[3]2,892	16.6	1.0	94**

[1]Eight or more trees (replicates) per treatment.
[2]Observations on cones on a 20-branch/tree sample.
[3]100% tally of mature cone crop on each tree.
** = t-test of the difference between check and spray means highly significant (P = 0.01).

Table 4.—*Laspeyresia ingens* infestation in second-year longleaf pine cones. Mist blower treatments, Columbia County, Florida

Test No.	Insecticide	Observation date	Cones bisected[1]	Mean infestation per tree		Reduction in cones infested
				Checks	Sprays	
			Number	*Percent*		*Percent*
1	dimethoate	Fall 1966	80	68.3	46.6	32 NS
2	dimethoate	Fall 1967	649	27.3	21.9	20 NS
3	fenthion	Fall 1967	707	27.3	25.4	7 NS
4	benzene hexachloride	Fall 1968	672	38.6	42.2	0 NS
5	azinphosmethyl	Fall 1968	784	38.6	4.7	88**

[1]If entire mature cone crop per tree was less than 50 cones, all cones were bisected; otherwise, a 50-cone sample was examined.
** = t-test of the difference between check and spray means highly significant (P = 0.01).

DISCUSSION

Four insecticides, dimethoate, fenthion, benzene hexachloride, and azinphosmethyl were tested in order to find an effective and economical insecticide for preventing seed losses in longleaf pine seed orchards. Fenthion did not significantly reduce cone and seed insect infestation. Dimethoate did prevent damage of conelets, but the poor protection of second-year cones from *Dioryctria* spp. and *L. ingens*, along with its high cost (table 5), make mist blower applications of this insecticide uneconomical for longleaf pine cone and seed insect control.

Table 5.—Relative insecticide costs[1] for mist blower applications tested for *Dioryctria* and *Laspeyresia* control on longleaf pine

Test No.	Insecticide	Concentration by weight of active toxicant	Cost/ tree/ application	Cost/ acre/ application	Cost/ tree/ year	Cost/ acre/ year[2]
		Percent	*Dollars*			
1	dimethoate	1.25	1.25	60.00	3.75	180.00
2	BHC	2.5	.75	36.00	2.25	108.00
3	azinphosmethyl	1.0	.60	28.00	1.80	84.00

[1]Labor costs excluded.
[2]Based upon 30- by 30-foot spacing (48 trees/acre).

Conelet abortion was not affected by the insecticide treatments, but the data collected during 1966 and 1967 substantiate earlier reports that abortion of first-year longleaf pine conelets represents a serious obstacle to maximizing seed production of this species.

Three applications of 2 gallons of 2.5 percent benzene hexachloride per tree reduced *Dioryctria* spp. damage by 56 percent when compared with the unsprayed check trees. BHC failed to reduce seedworm infestation, just as it failed to control the slash pine seedworm in previous experiments (Merkel and Yandle 1965). Three applications of 2 gallons of 1.0 percent azinphosmethyl per tree caused a reduction of *Dioryctria* spp. infestation of 94 percent, and *Laspeyresia ingens* infestation of 88 percent, when compared with the unsprayed check trees.

The total cost for material and labor for three applications of azinphosmethyl per tree, assuming a labor cost for two men at $2.00 per man-hour would be approximately $1.90 per tree. Therefore, the value of the increased seed yield per tree would have to be equal to, or greater than, $1.90 per tree in order to justify spraying. The longleaf trees we sprayed averaged 135 cones or approximately 1.5 bushels of cones per tree. Sixteen and one-half percent of the longleaf cone crop on the unsprayed trees in our Columbia County, Florida, plots were infested with *Dioryctria* spp. in 1968. These *Dioryctria*-caused seed losses amounted to approximately 0.25 bu. of cones or 0.185 lb. of seed per tree. Azinphosmethyl reduced *Dioryctria* infestation by 94 percent, and produced increased seed yields of 0.174 lb./tree. In addition, the unsprayed trees had an average of 0.63 seedworm larva/cone that caused seed losses of approximately 5 percent, or 0.06 lb. seed/tree. Azinphosmethyl reduced *Laspeyresia ingens* infestation by 88 percent, and thus increased seed yields by 0.053 lb. seed/tree. If a pound of longleaf pine seed from a seed orchard is assumed to be worth $10.00, the value of the increased seed yield due to cone and seed insect control is equal to 0.174 lb. + 0.053 lb. = 0.227 lb. seed/tree × $10.00/lb. = $2.27/tree. These calculations are based upon monetary seed values which we feel would be conservative for orchards of a genetically superior longleaf pine. In addition, the rates of infestation for *Dioryctria* and *Laspeyresia* which we encountered are quite low. Coyne estimated that an average of 21 percent of the annual seed crop was lost to *Laspeyresia* in the Gulf States. Finally, the calculations do not take into account any benefits gained by protecting first-year conelets from insect attacks.

Based upon the results of this study, azinphosmethyl is the most effective and economical (table 5) insecticide of the four we tested for protecting longleaf pine seed from cone and seed insects.

This publication reports research involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

CAUTION: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife—if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.

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